Appendix A

TECHNICAL APPENDIX

May 1998

A. OVERVIEW

The following technical appendix provides a comprehensive explanation of ABEL's calculations. This appendix is meant for financial analysts who wish to obtain a more complete understanding of how the ABEL model computes a firm's historic financial ratios as well as its ability to finance a penalty payment or Superfund contribution. Appendix B, Understanding ABEL's Financial Profile Results, helps the user to better assess the overall financial condition of the firm being analyzed. Appendix B also alerts the user to items to look for on a firm's tax returns.

The variables illustrated in Exhibit A-1 are necessary to fully understand the formulas presented in the remainder of this technical appendix. Exhibit A-1 also provides the associated line numbers from Form 1120 (1996). If the variables are computed internally by ABEL rather than direct inputs from the firm's tax returns, the table references the section in this appendix providing explanatory detail. In addition, the following subscripts apply to all of the variables used in the equations in this appendix:

- Subscript "j" indicates that the variable takes on a different value in each year. Subscript "j" is used only for historic data, with the most recent year's data corresponding to j=1 and the least recent year's data corresponding to either j=3, 4, or 5, depending on the number of years of available historic data.

- Subscript "k" is used for the value of variables in future years, with k=1 corresponding to the first future year and k=5 corresponding to the fifth future year. The beginning of the first future year corresponds to the point in time that the company invests in pollution control equipment as well as the year to which all future cash flows are discounted.

- Subscript "prob" indicates that the variable takes on a different value for each of seven different probability levels.

Exhibit A-1

DESCRIPTIONS OF ABEL TAX-FORM INPUTS AND DERIVED VARIABLES

Input Variable	Variable Definition	1996 1120 Tax Form Location or Derivation
ACTPAY	Accounts payable	Schedule L, Line 16
ACTREC	Accounts receivable less allowance for bad debts	Schedule L, Line 2b
ALOTAS	All other assets	ABEL calculation (see explanation of Balance Sheet in Section B)
AMORT	Amortization deduction	See attachment to Line 26, Other Deductions; "also review other attachments for declared amortization expenses"
ANN	Annual pollution control costs expressed in ANN$	Input on "Environmental Expenditures" Screen
ANN$	The year-dollars of ANN	Input on "Environmental Expenditures" Screen
ASSETS	Total liabilities and stockholders' equity	Schedule L, Line 27
$ATFC_{prob,k}$	After-tax future cash flow in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
AVCSH	Weighted-average value of XCASH	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
AZS	Altman's Z- Score	ABEL calculation (see explanation of Financial Ratios in Section C)
BNC	Income recorded on books not included in return	Schedule M-1, Line 7
BR	Beaver's Ratio	ABEL calculation (see explanation of Financial Ratios in Section C)
CAPCST	Depreciable capital cost of new investment in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
CAPND	Non-depreciable, nondeductible cost of new investment in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
CARFOR	NOL carryforward expressed in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D))
CASH	Cash	Schedule L, Line 1
CASH$	PTCASH expressed in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
CASHAT	After-tax cash flows	ABEL calculation (see explanation of Statement of Cash Flows in Section B)

Exhibit A-1

DESCRIPTIONS OF ABEL TAX-FORM INPUTS AND DERIVED VARIABLES

Input Variable	Variable Definition	1996 1120 Tax Form Location or Derivation
CASHAV	Simple average of CASH$, excluding most recent year	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
CDET	Mortgages, notes, bonds payable in less than one year	Schedule L, Line 17
$CHARGE_{prob}$	Present value of five years of $ATFCF_{prob,k}$	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
CLEAN	Non-depreciable but tax-deductible one-time costs expressed in CLEAN$	Input on "Environmental Expenditures" screen
CLEAN$	The year-dollars of CLEAN	Input on "Environmental Expenditures" screen
COMPANY _NAME	Name of the company being analyzed	Input on "Case Description Details" screen
CSTGDS	Cost of goods sold	Line 2
CR	Current Ratio	ABEL calculation (see explanation of Financial Ratios in Section C)
CRFUL	Credit for federal tax on fuels	Line 32d
CRREG	Credit from regulated investment companies	Line 32f
CURAS	Total current assets	ABEL calculation (see explanation of Balance Sheet in Section B)
CURLIB	Total current liabilities	ABEL calculation (see explanation of Balance Sheet in Section B)
DE	Debt-equity ratio	ABEL calculation (see explanation of Financial Ratios in Section C)
DEPL	Depletion deduction	Line 22
DEPR	Depreciation deduction	Line 20
EBIT	Earnings before interest and taxes	ABEL calculation (see explanation of Statement of Cash Flows in Section B)
EQUIP	Depreciable capital cost of new investment in EQUIP$	Input on "Environmental Expenditures" screen
EQUIP$	The year-dollars of EQUIP	Input on "Environmental Expenditures" screen

Exhibit A-1

DESCRIPTIONS OF ABEL TAX-FORM INPUTS AND DERIVED VARIABLES

Input Variable	Variable Definition	1996 1120 Tax Form Location or Derivation
EQUIV	Annual equivalent cash flow of CIVIL	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
EXPWT	Weights used to calculate weighted average of historical cash flows	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
FED	Government obligations	Schedule L, Line 4
FTR2	Reinvestment rate	Input on "Model Default Values" screen (Standard Value 0.0)
INC	Pre-tax, pre-NOL-deduction that will be equaled or exceeded with probability "prob"	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
INCAV	Weighted average of INC	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
INTR	Interest expense deduction	Line 18
INV	Inventories	Schedule L, Line 3
ITODAY	Year to which net present value and constant dollar calculations are made; same as penalty payment/ investment year	Input on "Environmental Expenditures" screen
LAND	Non-depreciable, nondeductible one-time costs in LAND$	Input on "Environmental Expenditures" screen
LAND$	The year dollars of LAND	Input on "Environmental Expenditures" screen
LST	Loans from stockholders	Schedule L, Line 19
LTD	Mortgages, notes, bonds payable in more than one year	Schedule L, Line 20
$MACRS_k$	Percentage of CAPCST to be depreciated in year k	Table from U.S. Master Tax Guide (see Ability to Pay Information in Section D)
MRY	Most recent year for which there are input data	Derived by ABEL based on tax return input information
NETSALES	Gross sales less returns and allowances	Line 1c

Exhibit A-1

DESCRIPTIONS OF ABEL TAX-FORM INPUTS AND DERIVED VARIABLES

Input Variable	Variable Definition	1996 1120 Tax Form Location or Derivation
NOL	Net operating loss deductions	Line 29a
NOL_{MRY}	Net operating loss deduction for most recent year of data	Line 29a on most recent year's tax return.
NOLIF	Number of years until NOL carryforward expended	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
NOLRD	NOLIF rounded to the nearest integer	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
NSD_{prob}	Number of standard deviations away from the mean of probability prob	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
NUMYRS	Number of years for which there are data	Input on "Case Description Details" screen
OCL	Other current liabilities	Schedule L, Line 18
OCR	Other current assets	Schedule L, Line 6
OLIB	Other liabilities	Schedule L, Line 21
ONM	ANN expressed in ITODAY dollars	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
OPERPRO	Operating profit	ABEL calculation (see explanation of Income Statement in Section B)
OTEXP	Other expenses (Income)	ABEL calculation (see explanation of Income Statement in Section B)
$PBCASH_{prob}$	Future pre-tax cash flow that will be equaled or exceeded with probability prob	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
$PBINC_{prob}$	Future pre-tax pre-NOL-deduction income that will be equaled or exceeded with probability prob	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
PENAL	Civil penalty expressed in ITODAY dollars	Input on "Environmental Expenditures" screen
PENPRB	Probability of being able to afford the penalty amount	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
PTCASH	Pre-tax, pre-reinvestment cash flow	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)

Exhibit A-1

DESCRIPTIONS OF ABEL TAX-FORM INPUTS AND DERIVED VARIABLES

Input Variable	Variable Definition	1996 1120 Tax Form Location or Derivation
PVTS	The present value as of ITODAY of five years of the tax shields associated with the initial capital investment	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
REAPP	Appropriated retained earnings	Schedule L, Line 24
RETEARN	Total retained earnings	ABEL calculation (see explanation of Financial Ratios in Section C)
REUNAPP	Unappropriated retained earnings	Schedule L, Line 25
SDCSH	Standard deviation of historic constant dollar pre-tax available cash flow	ABEL calculation (see explanation of Ability to Pay Calculations in Section D)
SMOOTH	Smoothing constant used in weighted average calculation	Input on "Model Default Values" screen (Standard value - 0.3)
SPDED	Special deductions	Line 29b
TAX	Total taxes	Line 31
TESEC	Tax-exempt securities	Schedule L, Line 5
TIBNOL	Taxable income before NOL & special deductions	Line 28
TIE	Times interest earned ratio	ABEL calculation (see explanation of Financial Ratios in Section C)
TOTEXP	Total expenses	ABEL calculation (see explanation of Income Statement in Section B)
TOTLIB	Total liabilities	ABEL calculation (see explanation of Balance Sheet in Section B)
TXRT	Total marginal tax rate	Input on "Model Default Values" screen
WC	Working capital	ABEL calculation (see explanation of Financial Ratios in Section C)
XINF	Annual inflation rate	Input on "Model Default Values" screen
YRS	Number of years over which the penalty payment will be spread	Input on "Model Default Values" screen

B. FINANCIAL PROFILE CALCULATIONS

This section of the appendix presents the methodology used in ABEL to calculate the summary balance sheet, income statement and summary of cash flows. The Financial Profile section of the ABEL results allows the user to compare a firm's financial performance over time. It is an easy way to spot inconsistencies within specific cost categories, as well as excessive variation in expenses, income, and deductions as claimed by a firm on its tax returns. For a more general description of a firm's financial profile results, consult Appendix B.

1. Balance Sheet

The balance sheet provides important information about a firm's assets and liabilities. The first section of the balance sheet illustrates a firm's assets. In this section, the entries for accounts receivable, cash, inventories, U.S. government obligations, tax-exempt securities, and other current assets are copied directly from data entered during the ABEL input session for each year. Because the user does not enter total assets during the input session, ABEL computes the figure as equivalent to total liabilities and stockholders' equity. All other assets, ALOTAS, is equivalent to total assets less accounts receivable, cash, inventories, U.S. government obligations, tax-exempt securities, and other current assets.

On the second half of the balance sheet ABEL calculates a firm's total liabilities. Entries for accounts payable, mortgages, bonds payable in less than one year, other current liabilities, loans from stockholders, mortgages, bonds payable in more than one year, and other liabilities are taken directly from data entered by the user during the ABEL input session for each year. ABEL then computes total liabilities, TOTLIB, by summing these entries. Finally, ABEL calculates stockholders' equity, EQUITY, by subtracting total liabilities from total liabilities and stockholders' equity, a figure entered during the ABEL input session.

Formulas:

ALOTAS = ASSETS - ACTREC - CASH - INV - FED - TESEC - OCR

TOTLIB = ACTPAY + CDET + OCL + LST + LTD + OLIB

EQUITY = ASSETS - TOTLIB

2. Income Statement

The income statement illustrates the firm's financial performance. It allows the user to identify whether the firm is generating profits from its daily business operations as well as whether its taxable income is positive. In addition, it highlights a few of the firm's expenses and deductions including depreciation, depletion, amortization, and interest expense spent on servicing its current outstanding debt. On the income statement, gross sales and cost of goods sold are copied directly from inputs entered during the data entry session. Operating profit, OPERPRO, is calculated as the difference between gross sales and cost of goods sold. Taxable income before net operating loss deductions is also entered during the data input session. This figure is then used to calculate total

expenses such that operating profit minus taxable income yields total expenses. Finally, other expenses (income) is derived as the difference between total expenses less interest expense, deprecation, depletion and amortization.

Formulas:

OPERPRO = NETSALES - CSTGDS

TOTEXP = OPERPRO - TIBNOL

OTEXP = TOTEXP - INTR - DEPR - DEPL - AMORT

3. Estimated Cash Flows

ABEL calculates a firm's historic cash flows using the methodology employed in the ability to pay section (Section D). ABEL first calculates available after-tax cash flow. This figure is equivalent to taxable income before net operating losses less taxes paid plus credit for regulated investment companies, credit for federal tax on fuels, depreciation, depletion, amortization, and income recorded on books not included in the return. Finally, ABEL calculates a firm's inflation adjusted available pre-tax cash flows. The calculation uses the inflation rate entered by the user on the "Model Default Values" screen.

Formulas:

CASHAT = TIBNOL - TAX + CRREG + CRFUL + DEPR + DEPL + AMORT + BNC

The historic pre-tax available cash flow, $XNCASH_j$, is calculated as:

$$XNCASH_j = CASHAT_j + TAX_j - DEPR_j$$

Like the historical data provided, these calculations yield available cash flow figures expressed in current (nominal) dollar terms.

Next, ABEL converts the current dollar pre-tax historic available cash flows into inflation-adjusted constant (real) dollars as of the base year (the year that the company will be making the environmental expenditure and/or paying the penalty). This year is represented by the input variable ITODAY. The equation is:

$$XCASH_j = XNCASH_j * [(1 + XINF)^{(ITODAY - MRY + j - 1)}]$$

where "j" in the exponent takes on the same values as the subscripts j. For this equation to correctly convert current dollars into constant dollars, it is essential that all historic data are for consecutive years.

The annual inflation rate, XINF, is assigned a standard value unless modified by the user on the "Model Default Values" screen.

C. FINANCIAL RATIO CALCULATIONS

This section of the appendix presents the methodology used in ABEL to calculate the five financial ratios. These ratios are often used to evaluate a firm's overall viability and financial structure. Refer to Exhibit A-1 for variables used in the formulas.

1. Debt to Equity Ratio

Formulas:[1]

$$DE = \frac{TOTLIB}{EQUITY} \quad \text{where}$$

EQUITY = ASSETS - TOTLIB and

TOTLIB = ACTPAY + CDET + OCL + LST + LTD + OLIB.

Notes:

If ASSETS = TOTLIB, then ABEL prints "na," indicating that the ratio cannot be computed. A Debt to Equity ratio of "na" indicates that stockholders' equity is zero, a serious financial condition.

2. Current Ratio

Formulas:

$$CR = \frac{CURAS}{CURLIB} \quad \text{where}$$

CURAS = CASH + ACTREC + INV + FED + TESEC + OCR

and

CURLIB = ACTPAY + CDET + OCL

[1] All data for the financial ratios' calculations come from the same year. This is different from the Ability to Pay calculations, described in the next section of this appendix, which references data from different years.

Notes:

If CURAS >= 0 and CURLIB = 0, then the current ratio will be assigned a value of "na" for that year. The value of CURAS will determine the category into which that year's current ratio will be classified in ABEL's detailed explanations of the historic financial ratios:

- Those years for which CURAS = 0 and CURLIB = 0 will be classified as having a Current Ratio between 1.0 and 2.0.

- Those years for which CURAS > 0 and CURLIB = 0 will be classified as having a Current Ratio greater than 2.0.

3. Times Interest Earned Ratio

Formulas:

$$TIE = \frac{EBIT}{INTR} \quad \text{where}$$

$$EBIT = INTR + TIBNOL$$

Notes:

A value of "na" will be assigned to the Times Interest Earned ratio for those years in which INTR = 0. A TIE of "na" indicates that the firm had no interest expense in that year. This situation is inconclusive because it may result from one of two very different situations. If a firm does not pay interest during a given year, then it may not have any outstanding debt that requires servicing. This situation is generally indicative of a strong financial position. However, a firm may also be struggling financially and not have the ability to meet its current interest requirements. This situation is generally indicative of a downward trend in the firm's financial profile.

4. Beaver's Ratio

Formulas:

$$BR = \frac{CASHAT}{TOTLIB} \quad \text{where}$$

$$CASHAT = TIBNOL - TAX + CRREG + CRFUL + DEPR + DEPL + BNC$$

Notes:

The above equation for after-tax cash flow (CASHAT) does not, strictly speaking, include all items that affect cash flow. Not included are changes in non-cash working capital, capital expenditures paid for with cash, dividends, and cash flow resulting from debt and equity financing. The above definition of cash flow was chosen for calculating Beaver's Ratio (BR) because it most closely replicates the definition used by William Beaver in related study (i.e., cash flow equals after-tax net income plus depreciation plus depletion).[2] Also, Beaver's definition was used as the basis for determining healthy/unhealthy BR cutoff values.[3]

If TOTLIB = 0, Beaver's ratio will be assigned a value of "na" for that year. A BR of "na" indicates that the firm had no liabilities in that year. Because this situation is unusual, ABEL will recommend that the user check that year's tax return data against all inputs before proceeding.

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[2] William H. Beaver, "Financial Ratios as Predictors of Failure," in Empirical Research in Accounting: Selected Studies, 1966, pages 71-111.

[3] Note that the above equation for cash flow is quite sound without requiring an excessive number of ABEL inputs. ABEL utilizes an identical definition of cash flow in its ability to pay conclusion except that it also takes into account reinvestment in equipment (i.e., capital expenditures). Thus, the implicit cash flow assumptions are that net non-cash working capital is at a steady-state level, there are no dividends (or if there are, they can be discontinued in order to finance capital expenditures or to pay penalties), and that the only sustainable cash flows are those from operations rather than from debt or equity financing.

5. Altman's Z-Score[4]

Formulas:

$$AZS = (0.717 * Z_1) + (0.847 * Z_2) + (3.107 * Z_3) + (0.420 * Z_4) + (0.998 * Z_5) \quad \text{where}$$

$$Z_1 = \frac{CURAS - CURLIB}{ASSETS}$$

$$Z_2 = \frac{REAPP + REUNAPP}{ASSETS}$$

$$Z_3 = \frac{EBIT}{ASSETS}$$

$$Z_4 = \frac{EQUITY}{TOTLIB}$$

$$Z_5 = \frac{NETSALES}{ASSETS}$$

Notes:

If ASSETS = 0 or TOTLIB = 0, ABEL will assign that year's Altman's Z-Score (AZS) a value of "na." An AZS of "na" indicates that a numerical value could not be computed for that year because either total assets or total liabilities were equal to zero. Because these situations are unusual, ABEL will recommend that the user check the actual tax return against all data inputs for that year before proceeding.

D. ABILITY TO PAY CALCULATIONS

This section presents ABEL's ability to pay calculations and decision rules. ABEL discounts a firm's projected internally generated cash flows back to the date on which the firm will incur the environmental expenditure. All after-tax cash flows associated with the pollution control activity and penalty are subtracted out of these cash flows to estimate the funds that will remain after these

[4] Edward I. Altman, Corporate Financial Distress: A Complete Guide to Predicting, Avoiding and Dealing with Bankruptcy, 1983, and "The Success of Business Failure Prediction Models", Journal of Banking and Finance, Vol. 8, pages 171-198, June 1984.

expenditures. If the present value of these net cash flows is greater than or equal to zero, the firm is deemed able to pay for both the pollution control expenditures and the penalty. If the present value is negative, however, the firm is deemed unable to fund all or a portion of the expenditures and/or penalty.

While the technique of discounting cash flows is well accepted by the financial community, the actual implementation in this context is quite complex. To begin, seven main steps are involved in the ability to pay calculations:

1. Calculate the firm's pre-tax historic available cash flows;

2. Adjust the historic available cash flows for inflation;

3. Compute the mean and standard deviation of the historic inflation-adjusted pre-tax available cash flows;

4. Estimate the firm's future available pre-tax cash flows;

5. Compute the present value of five years of the firm's future available after-tax cash flows;

6. Compute the present value of five years of the after-tax cash flows associated with the new (pollution control and penalty) expenditures; and

7. Compute the resulting net present value of all cash flows and adjust it for the penalty payment.

1. Detailed Ability to Pay Calculations

Refer to Exhibit A-1 in Section A of this appendix for definitions of the variables used in the ability to pay calculations.

Step 1: Calculate Pre-Tax Historic Available Cash Flow

ABEL first calculates the historic pre-tax available cash flow, $XNCASH_j$:

$$XNCASH_j = CASHAT_j + TAX_j - [FTR2 * DEPR_j]$$

where the reinvestment rate, FTR2, is assigned a standard value of 0.0 unless modified by the user on the "Model Default Values" screen. Like the historical data provided, these calculations yield available cash flow figures expressed in current (nominal) dollar terms. A firm's pre-tax historic available cash flows can be found on the Financial Profile section of the ABEL model output.

Step 2: Adjust Available Cash Flows for Inflation

ABEL again converts the current dollar pre-tax historic available cash flows into inflation-adjusted constant (real) dollars as of the base year (the year that the company will be making the environmental expenditure and/or paying the penalty). This year is represented by the input variable ITODAY. The equation is:

$$XCASH_j = XNCASH_j * [(1 + XINF)^{(ITODAY - MRY + j - 1)}]$$

where "j" in the exponent takes on the same values as the subscripts j. For this equation to correctly convert current dollars into constant dollars, it is essential that all historic data are for consecutive years.

The annual inflation rate, XINF, is assigned a standard value unless modified by the user on the "Model Default Values" screen. A firm's inflation adjusted pre-tax cash flows can be found on the Financial Profile section of the ABEL model output.

Step 3: Compute Mean and Standard Deviation of Historic Constant Dollar Pre-Tax Available Cash Flows

The equation for the weighted average of the constant dollar historic pre-tax available cash flows, AVCSH, is:

$$AVCSH = \sum_{j=1}^{NUMYRS} (XCASH_j * EXPWT_j) \quad \text{where}$$

$$EXPWT_j = \frac{SMOOTH * (1 - SMOOTH)^{j-1}}{SMSUM}$$

$$\text{and} \quad SMSUM = \sum_{j=1}^{NUMYRS} [SMOOTH * (1 - SMOOTH)^{(j-1)}]$$

The variance and standard deviation of the historic constant dollar pre-tax available cash flows are computed using the following equations:

$$SDCSH = VARCSH^{0.5} \quad \text{where}$$

$$VARCSH = \sum_{j=1}^{NUMYRS} \frac{(XCASH_j - AVCSH)^2 * EXPWT_j * NUMYRS}{NUMYRS - 1}$$

Step 4: Estimate Future Available Pre-Tax Cash Flows

This equation calculates the constant dollar available cash flows that a firm can be expected to generate in the future at different probability levels. We assume that the firm's total population of all of its historic constant dollar available cash flows are normally distributed.

ABEL employs the T-distribution as the basis for estimating probabilities, because of the small number of data points used in the calculations. In general, if a population is normally distributed, then one can estimate the percentage of data points in the population that will exceed a particular value by using a standard normal table. Even if we are only dealing with a subset of the entire population, we can still use the standard normal table to estimate percentages (probabilities), providing the sample is large enough, typically in excess of fifteen to thirty data points. When the population is normally distributed but the sample size is very small, the T-distribution table is the analytically correct approach for estimating probabilities. The T-distribution, also referred to as the sampling distribution, has the same symmetrical bell-shaped curve as the normal distribution. It is somewhat flatter and lower at the mean, however, as well as somewhat more dense in the two tails than the normal distribution.

The calculation of the future expected pre-tax cash flow, at each probability level, is calculated as follows:

$$PBCSH_{prob} = AVCSH - (SDCSH * NSD_{prob})$$

In this equation, the value of NSD_{prob} is taken from the look-up table shown in Exhibit A-2. These T-distribution values can be found in any statistics book; two books are listed in Exhibit A-2 for reference purposes.

Exhibit A-2

VALUE OF NSD_{prob}

	Number of Years of Historic Data		
Probability	**3**	**4**	**5**
50%	0.000	0.000	0.000
60%	0.289	0.277	0.271
70%	0.617	0.584	0.569
80%	1.061	0.978	0.941
90%	1.886	1.638	1.533
95%	2.920	2.353	2.132
99%	6.965	4.541	3.747

Sources:
1. E. Mansfield, Statistics for Business and Economics, Third Edition, W.W. Norton & Co., 1987, p. A16.
2. Pindyck & Rubinfeld, Econometric Models & Economic Forecasts, Second Edition, McGraw-Hill, 1981, p. 608.

For example, the equation for the minimum pre-tax cash flow that we could expect to obtain 80% of the time, using five years of data, is:

$$PBCSH_{80\%} = AVCSH - (SDCSH * 0.941)$$

Step 5: Compute Present Value of Future Available After-Tax Cash Flows

The present value of five years of expected future available after-tax cash flows for a given probability level, designated as $CHARGE_{prob}$, is calculated from the following equation:[5]

[5] This discussion assumes that the user selected the default value of 5 years of future cash flow considered available for penalty or contribution to EPA. If the user entered 2, 3, or 4 years of future cash flow, then ABEL would calculate the sum of after-tax cash flow for the appropriate number of years.

$$CHARGE_{prob} = \sum_{k=1}^{5} ATFCF_{prob,k} * \left[\frac{1 + XINF}{1 + XNRATE}\right]^{k - 0.5}$$ where

$$ATFCF_{prob,k} = PBCSH_{prob} - TAXES_{prob,k}$$

In this equation $ATFCF_{prob,k}$ represents the after-tax future available cash flow for year "k" and probability level "prob." The value of this variable corresponds to constant ITODAY dollars, as can be seen from Steps 2 through 4 above. In the ABEL model output, CHARGE is listed under "Total Cash Flow Generated by a Firm."

A number of comments are necessary to clarify the previous set of equations:

- In the equation for $CHARGE_{prob}$, first we inflate $ATFCF_{prob,k}$ to nominal year "k" dollars and then we discount that cash flow back to ITODAY using the firm's nominal discount rate. The calculation is made in this manner because finance theory dictates that nominal cash flows be discounted at the nominal discount rate and real cash flows be discounted at the real interest rate.
- The exponent in the equation for $CHARGE_{prob}$ uses half-years since the company's annual cash flows are assumed to occur in the middle of each year. This convention balances off cash flows which occur in the first half of the year with those that occur in the second half of the year.
- XNRATE, the weighted average cost of capital, is an after-tax discount rate and is applied to after-tax cash flows.

$TAXES_{prob,k}$ are calculated as follows. This calculation is complex since we must estimate the number of years before the most recent year's net operating loss (NOL) carryforward is expended, and calculate the amount of income on which taxes are based for the seven different probability levels.

a. Calculate historic pre-tax pre-NOL-deduction income in ITODAY dollars:

$$INC_j = (TIBNOL_j - SPDED_j) * (1 + XINF)^{(ITODAY - MRY + j - 1)}$$

b. Calculate the historic weighted average of pre-tax pre-NOL-deduction income in ITODAY dollars, denoted by INCAV:

$$INCAV = \sum_{j=1}^{NUMYRS} (INC_j * EXPWT_j)$$

c. Calculate the standard deviation of historic pre-tax pre-NOL-deduction income in nominal ITODAY dollars:

$$SDINC = \left[\sum_{j=1}^{NUMYRS} \frac{(INC_j - INCAV)^2 * EXPWT_j * NUMYRS}{NUMYRS - 1} \right]^{.5}$$

d. Calculate the future expected pre-tax pre-NOL-deduction income which will be equaled or exceeded with a given probability, $PBINC_{prob}$:

$PBINC_{prob} = INCAV - (SDINC * NSD_{prob})$

where the value of NSD_{prob} is taken from the "look-up" table presented in Exhibit A-3.

e. Calculate the NOL carryforward, as of the end of the most recent year of historic data, expressed in ITODAY dollars:

CARFOR = Minimum of 0 or

$(TIBNOL_{MRY} - NOL_{MRY} - SPDED_{MRY}) * (1 + XINF)^{(ITODAY - MRY)}$

Note that the NOL carryforward is expressed as a negative number.

f. Calculate the number of years after the most recent year of historic data until the NOL carryforward will be completely expended:

$$NOLIF = \frac{-CARFOR}{INCAV}$$ where

NOLRD = NOLIF rounded up/down to the nearest integer. Note that if NOLIF is exactly 0, then NOLRD would also be exactly 0.

g. Use the decision rules shown in Exhibit A-3 to determine $TAXES_{prob,k}$.

Exhibit A-3

DECISION RULES FOR CALCULATING FUTURE YEARS' TAXES

CARFOR	$PBINC_{prob}$	Decision Rule
= 0	> 0	Calculate $TAXES_{prob,k}$ = TXRT * $PBINC_{prob}$ for all k.[6]
= 0	<= 0	$TAXES_{prob,k}$ = 0 for all k[7]
< 0	<= 0	$TAXES_{prob,k}$ = 0 for all k[8]
< 0	> 0	The company will begin paying taxes after its NOL carryforward has been expended. a. If (k - 1 + ITODAY - MRY) <= NOLRD, then $TAXES_{prob,k}$=0. b. If (k - 1 + ITODAY - MRY) > NOLRD, then $TAXES_{prob,k}$ = TXRT * $PBINC_{prob}$.

Source: The tax rates are taken from the Federation of Tax Administrators.

Step 6: Compute Present Value of After-Tax Cash Flows Associated with New Capital Investment

Three primary components of new pollution control capital investments affect after-tax cash flow: (1) the original capital investment; (2) the depreciation and deduction tax shields associated with the investment (corresponding to EQUIP and CLEAN, respectively); and (3) the annual operating expenses. The equation for the present value of five years of after-tax cash flows for each of these is developed below.

[6] The company has no NOL carryforward and a positive taxable income at this probability level, so must pay taxes in all years.

[7] The company has no NOL carryforward but has negative taxable income at this probability level. The company will not pay any taxes and will build up an NOL carryforward.

[8] The company has an NOL carryforward and negative taxable income at this probability level. The company will not pay any taxes, and its NOL carryforward will grow in size.

a. Calculate the present value of the initial capital investment, denoted by PVCAP, as of the beginning of ITODAY:

PVCAP = - CAPCST - CAPND - TXND.

The initial capital investment consists of a single cash outflow at the beginning of ITODAY, and consists of three parts:

- CAPCST is the constant dollar depreciable capital cost of the new pollution control investment.

- CAPND is the constant dollar nondepreciable, non-tax-deductible one-time costs of the new investment.

- TXND is the constant dollar nondepreciable but tax-deductible capital one-time costs.

PVCAP + PVTS is labeled "Initial Pollution Control Expenditures" on the ABEL model output.

Since the above capital cost cash flows all occur at the beginning of year ITODAY, there is no need to discount them; they already represent present values. To obtain the constant ITODAY-dollar capital costs, however, we need to adjust the user-entered capital costs:

$$CAPCST = EQUIP * (1 + XINF)^{(ITODAY - EQUIP\$)}$$

where EQUIP is the user-provided CAPCST expressed in year EQUIP$ dollars.

$$CAPND = LAND * (1 + XINF)^{(ITODAY - LAND\$)}$$

where LAND is the user-provided CAPND expressed in year LAND$ dollars.

$$TXND = CLEAN * (1 + XINF)^{(ITODAY - CLEAN\$)}$$

where CLEAN is the user-provided TXND expressed in year CLEAN$ dollars.

b. Calculate the present value of the tax shields, PVTS, associated with the initial capital investment, as of ITODAY.

There are two sources of tax shields corresponding to the initial pollution control capital investment, both of which serve to reduce taxes and thereby increase cash flow. The two sources are the depreciation tax shields associated with CAPCST and the nondepreciable but tax-deductible items, represented by TXND, that are written off for tax purposes in year ITODAY.

In order to be consistent with the Tax Reform Act of 1986 and the July 1990 version of BEN, CAPCST will be depreciated under the Modified Accelerated Cost Recovery System

(MACRS). MACRS calls for the use of double declining balance (DDB) depreciation with half-year convention, a seven year life, and a switch from DDB to the straight line method in the fifth year. The switch is made in the year depreciation equals or exceeds that determined under DDB in order to maximize the depreciation deduction. The total depreciation and deduction tax shield for the year in which the investment is made (i.e., k=1) is:

$$TS_{k=1} = TXRT * [(CAPCST * .14286) + TXND]$$

where the value of .14286 is taken from a MACRS depreciation schedule.[9]

For years k=2 to 5, the total tax shield consists solely of the depreciation tax shield and is given by the formula:

$$TS_k = TXRT * CAPCST * MACRS_k$$

where $MACRS_k$ is taken from the following table:[10]

k	$MACRS_k$
2	0.24490
3	0.17493
4	0.12495
5	0.08925

The present value as of ITODAY of five years of the tax shields associated with the initial capital investment is given by:

$$PVTS = \sum_{k=1}^{5} \frac{TS_k}{(1 + XNRATE)^{k-0.5}}$$

Note that it is not appropriate to inflate the tax shields to current dollars before discounting them since the actual depreciation in any year is a fixed dollar amount, and is thus already in each year's current dollars. Also, we use the weighted average cost of capital as the discount rate since

[9] For example, refer to p. 307 of the 1990 U.S. Master Tax Guide.

[10] *Ibid.*

it incorporates the firm's overall risk level. Finally, the exponent in the equation for PVTS uses half-years since tax shields increase cash flow and the company's annual cash flows are assumed to occur in the middle of each year, as discussed previously.

c. Calculate the present value of the after-tax annual cash flows, PVONM, as of ITODAY:

$$PVONM = -ONM * (1 - TXRT) * \sum_{k=1}^{5} \left[\frac{1 + XINF}{1 + XNRATE} \right]^{k-0.5}$$

where ONM represents the annual expense (ANN), expressed in ITODAY dollars.

The value provided by the user for this expense must, however, first be converted into ITODAY dollars:

$$ONM = ANN * (1 + XINF)^{(ITODAY - ANN\$)}$$

where ONM is the user-provided ANN expressed in year ITODAY dollars.

The above equation for the present value of annual expenses assumes that these expenses escalate at the inflation rate and that they occur in the middle of the year. The weighted average cost of capital is again used as the discount rate. PVONM is labeled "Total Annual Pollution Control Costs" on the ABEL model output.

Step 7: Compute Resulting Net Present Value of Five Years of After-Tax Future Cash Flows for All Probability Levels

$$XNET_{prob} = CHARGE_{prob} + PVONM + PVTS + PVCAP$$

where $XNET_{prob}$ represents the present value, as of the beginning of ITODAY, of five years of net after-tax cash flows available to the firm for discretionary uses. XNET is labeled "Firm Cash Flow Net of Penalty/Contribution and Pollution Control Expenditures" on the ABEL model output.

Note that this does not mean that the firm will have enough cash on hand as of ITODAY to make a lump sum penalty payment equal to $XNET_{prob}$. If the firm's current financial position is strong, however, as determined in the Financial Ratios section, and XNET is sufficiently large with, for example, an 80% confidence level, then ABEL assumes that the firm would be able to obtain additional debt or equity financing sufficient to pay a lump sum penalty of that amount.

Step 8: Convert the Penalty into an Annual Equivalent Cash Flow

Rather than paying a single lump-sum penalty at the beginning of ITODAY, the government may wish to allow a company to spread payment of that penalty over several years in equal installments. The first installment would occur during ITODAY and the remaining installments would occur at the same time during each of the following years. This option is presented to the user during the input phase on the "Model Default Values" screen. The annual installment amount is:

$$EQUIV = \frac{CIVIL}{1 + \sum_{k=1}^{YRS-1} \frac{1}{(1 + XNRATE)^k}}$$

where CIVIL is the penalty input as PENAL in ITODAY dollars.

Note that this annual installment is already expressed in current dollar terms since the equation was derived by discounting nominal cash flows at the firm's nominal interest rate. It also assumes that the initial payment is paid as of ITODAY. For standard ABEL cases, XNRATE is equivalent to the value entered on the Model Default Values Screen. For Superfund ABEL cases, the Superfund interest rate is used to calculate annual equivalent cash flow.[11]

[11] Consistent with EPA policy outlined in a memorandum titled *General Policy on Superfund Ability to Pay Determinations*, dated 30 September 1997, the Superfund interest rate should be used to calculate ability to pay settlements that include payments over time. The Superfund interest rate that should be used through September 30, 1998 is 5.61 percent. This rate is based on the investment rate of the Superfund trust fund. All Superfund contributions are invested annually in one type of treasury bill. The Superfund AtP rate is approximately equal to the yield on this bill.

Step 9: Calculate the Probability Level Associated with the Penalty Amount Using Linear Interpolation

ABEL will have previously computed the values in the right hand column of the following table:

Probability	Value
50%	$XNET_{prob=50\%}$
60%	$XNET_{prob=60\%}$
70%	$XNET_{prob=70\%}$
80%	$XNET_{prob=80\%}$
90%	$XNET_{prob=90\%}$
95%	$XNET_{prob=95\%}$
99%	$XNET_{prob=99\%}$

A computer algorithm calculates the probability level associated with a given penalty amount, as follows:

1. Determine the two consecutive values in the right column of the above table between which CIVIL falls.

2. Perform a linear interpolation to determine the probability level associated with CIVIL. Assign that probability level as a string to the variable PENPRB.[12]

3. If the numerical value of PENPRB < 60%, then set PENPRB equal to the string "less than 50."

4. If the numerical value of PENPRB > 99%, then set PENPRB equal to the string "99+."

[12] For example, if $XNET_{prob=80\%} = 100$, $XNET_{prob=90\%} = 70$, and CIVIL = 80, then PENPRB = 90 - (90 - 80) * [(80 - 70) ÷ (100 - 70)] = 86.7 86.7 would then be converted to the string "86.7."

E. ABILITY TO PAY CALCULATIONS FOR SUPERFUND CASES

ABEL also calculates a firm's ability to pay a Superfund contribution. The difference between traditional ABEL calculations and Superfund ABEL calculations involves how the model evaluates a firm's cash flows. Superfund ABEL evaluates a firm's ability to pay on a pre-tax basis because remediation costs are generally tax-deductible, whereas standard penalty payments are non-tax-deductible. The method in which ABEL computes a firm's financial profile and ratios for a firm in violation of CERCLA regulations is exactly the same as for a standard ABEL case. See Sections B and C in this technical appendix for more information on these calculations.

In analytic terms, the ABEL model calculates a firm's "Affordable Annual Costs" as equivalent to $PBCSH_{prob}$, discussed in Section D, Step 4 of this appendix. This equation calculates the constant dollar pre-tax available cash flows that a firm can be expected to generate in the future at different probability levels. Finally, ABEL calculates a firm's "Affordable One-Time Charge" as the present value of five years expected future available pre-tax cash flows for a given probability level ($PBCSH_{prob}$) using the inflation rate and discount rate entered on the "Model Default Values" screen. This calculation is equivalent to $CHARGE_{prob}$, with the exception that it includes pre-tax cash flows as opposed to after-tax cash flows used in standard ABEL cases. This calculation is discussed in Section D.5 of this appendix. The "Cash Flow Net of Superfund Cleanup Cost" is simply $CHARGE_{prob}$ less the Superfund contribution specified by the user on the "Environmental Expenditures" screen.

Formulas:

$$PBCSH_{prob} = AVCSH - (SDCSH * NSD_{prob})$$

$$CHARGE_{prob} = \sum_{k=1}^{5} PTFCF_{prob,k} * \left[\frac{1 + XINF}{1 + XNRATE}\right]^{k-0.5}$$

F. DECISION RULE FOR CHANGING SMOOTHING CONSTANT

ABEL will occasionally suggest that the user adjust the smoothing constant. ABEL compares the average income generated over all years except the most recent year with cash flows generated in the most recent year. If the most recent year's cash flow is significantly better or worse than the historical average, ABEL will recommend changing the smoothing constant.

ABEL will suggest changing the smoothing constant to 0.7 (i.e., placing more significance on the most recent year of data) if:

$$CASHD_{j=1} < \frac{AVCASHD}{2}$$

or $CASHD_{j=1} < 0$ and $TMP < 0$

Formulas:

$$PTCASH_j = CASHAT_j + TAX_j$$

$$CASHD_j = PTCASH_j * (1 + XINF)^{j-1}$$

$$AVCASHD = \sum_{j=2}^{NUMYRS} \frac{CASHD_j}{NUMYRS}$$

$$TMP = \sum_{j=1}^{NUMYRS} CASHD_j + EXPWT_j$$